Reports

Integrated Analysis of Metallic Resource Flows

A Report on a New Research Programme

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Abstract

In January 1997, the German Research Association (DFG) established a special research programme for an integrated analysis of metallic resource flows. The programme is a joint interdisciplinary effort of the Technical University of Aachen and of the Research Centre Jülich. Apart from many other activities, a series of conferences is organised within this programme. In October 1997, a first conference was held on "The Economics of Resource Flows: The Case of Aluminium". In December 1997, a second conference took place on "Life Cycle Assessment of Aluminium: Methods and Applications". In April 1998 the third workshop was held entitled "Methodological Aspects of a Resource-oriented Analysis of Material Flows". The next conference is planned for December 1998 on "Environmental related Aspects of Aluminium Production". Finally, a conference on "Methods for an Integrated Evaluation of Material Flows" is under consideration for 1999.

Keywords: Aluminium; economics; impact assessment; integrated analysis; inventory; metals; Life Cycle Assessment; policy instruments; resource flows; sustainability

1 Introduction

For most economies, the use of metallic resources is of fundamental relevance. The world-wide production of such metals as iron, aluminium, copper, zinc and lead shows considerable growth. For instance, the annual production of primary aluminium went up by a factor of 10 between 1950 and 1995. On the one hand, this implied a corresponding increase of materials, energy and land use which was accompanied by a rise in transport, in emissions and in material flows at ore deposits. On the other hand, aluminium is used in many innovative applications, for instance in order to reduce product weight.

As resources are scarce, a resource-oriented management of the anthropogeneous resource flows is of high social interest. Thus the German Research Association (DFG) set up a special research programme for an integrated analysis of metallic resource flows (SFB 525). The research programme is a joint interdisciplinary effort by the Technical University of Aachen and the Research Centre Jülich. The programme focuses on an integration of the technical, economic, environmental and social aspects of metallic resource flows. This includes a consideration of the use of materials, energy, environment, labour and capital. It aims at developing strategy recommendations for the agents which are responsible for shaping the global metal flows. Future scenarios concerning market structures, environmental burdens and technical advances are proposed on a regional, a national and a global level.

The research programme investigates both the processes of primary metal production (based on mining) and the processes of secondary metal production (based on scrap recovery). Apart from mining and scrap recovery, the processes under investigation primarily include ore processing, smelting, remelting, manufacturing, waste disposal, transport and energy supply. Initially, the research programme focuses on the global resource flows with regard to aluminium production, but other metallic resource flows will be addressed subsequently as well.

The structure of the research programme is shown in **Figure 1.** Sub-programmes 1 to 8 are located at the Technical University of Aachen, and sub-programme 9 is located at the Research Centre Jülich.

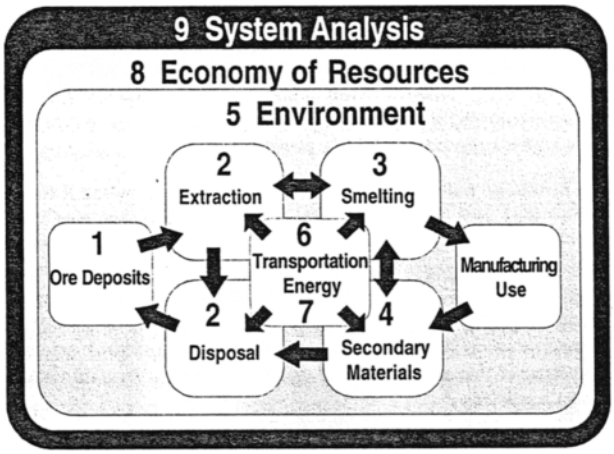

Fig. 1: The structure of research programme SFB 525

In the framework of the research programme, a sequence of conferences and workshops has been organised in order to provide a platform for discussion and the exchange of information among members of the research programme and all interested parties from scientific institutions and industry. The results of the first three conferences of the research programme are described in the following paragraphs with focus on the LCA workshop.

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2 The Economics of Resource Flows: The Case of Aluminium

On October 23-24, 1997, the research programme held a conference on "The Economics of Resource Flows: The Case of Aluminium". The conference was mainly organised by sub-programme 9 (Research Centre Jülich, Programme Group System Analysis and Technology Evaluation (STE)). The conference took place in Kerkrade, the Netherlands, and was attended by 40 participants from the Technical University of Aachen, the Research Centre Jülich, other research institutions, the German aluminium industry, the German Aluminium-Industry Association (GDA) and the German Federal Ministry of Environment.

The aim of the conference was to provide an overview of methods for an economic analysis of global resource flows regarding aluminium production. The workshop made clear that resource flows are essentially shaped by the strategies of firms, consumers and public authorities. Thus, there is a need for understanding the incentives which are driving the agents' involvement in the global resource flows. In the course of interactive decision making, the agents often follow divergent individual interests. This leads to conflict potentials on the one hand. However, it also gives rise to cooperation opportunities on the other hand. By cooperating, firms, consumers, and public authorities can enhance the sustainability of the global resource flows. In this spirit, the workshop pointed out several aspects in the realm of technology, economics and ecology where efficiency improvements can be realised.

3 Life Cycle Assessment for Aluminium: Methods and Applications

Moreover, on December 4-5, 1997, the sub-programme 9 of the research programme organised a conference on "Life Cycle Assessment for Aluminium: Methods and Applications" in Bad Honnef. The conference was attended by 70 participants from similar institutions as in the case of the first workshop.

The aim of the workshop was to provide an overview of the progress in Life Cycle Assessment (LCA) and, in particular, in the methods for Life Cycle Inventory (LCI). The lectures mainly addressed the material and energy flows involved in the primary and secondary production of aluminium. The workshop was divided into a sequence of two sessions, each with five presentations: A. Methodology and progress in LCA, B. Current case studies on aluminium. Session A addressed the activities towards the ISO 14040 series and methods for LCA with regard to allocation and data-quality assessment. Furthermore, a hybrid method combining technical process-chain analysis and economic input-output analysis was presented. Finally, several methods and tools for Life Cycle Impact Assessment (LCIA) and energy accounting such as the Cumulative Energy Demand (CED) were described. In Session B, reports were given concerning several aluminium case studies carried out by the European aluminium industry, EMPA/ETH Zurich, University of Stuttgart (IKP), Öko Institute Darmstadt and Wuppertal Institute.

The workshop showed that LCI, as guided by ISO 14041, is the least controversial and in fact the most objective part of LCA. Nevertheless, some methodological problems such as the appropriate choice of system boundaries, functional units or allocation procedures are still not solved conclusively. Moreover, consistent approaches are still needed for dealing with uncertainty in the context of LCA and LCI. At present, mathematical methods involving intervals or fuzzy sets are hardly ever applied. Nonetheless, issues such as transparency of assumptions, disclosure of data and error estimation should be given more attention to allow a reliable assessment of LCI and LCA results. Apart from LCI, LCIA was briefly addressed during the workshop. The discussion pointed out that the assessment of environmental impacts by means of LCIA requires a consideration of spacial and temporal aspects. Moreover, the possibility of including the CED in the LCIA is currently under discussion.

4 Methodological Aspects of a Resource-Oriented Analysis of Material Flows

On April 23-24, the third workshop was held in Bergisch Gladbach entitled "Methodological Aspects of a Resource-oriented Analysis of Material Flows". The workshop was again organised mainly by sub-programme 9 and was attended by 45 participants from similar institutions as in the case of the other two workshops.

The workshop focused on methodological issues related to identification, characterization and evaluation of material flow systems. The following four topics were covered: economics of resource flows, material flow systems, operations research methods applied to environmental issues and recycling models.

In particular, the workshop stressed the role of economic and mathematical models for solving complex problems in the area of environmental protection. The strategies obtained with such models give an important contribution to decision making processes.

5 Conclusion and Future Outlook

The three conferences contributed considerably to an increased understanding of the different methods that will be applied by the research programme SFB 525. In particular, the meetings have helped to strengthen the interdisciplinary teamwork within the research programme at the Technical University of Aachen and at the Research Centre Jülich. Moreover, the research programme has benefited from the intense discussions with experts from other research institutions, industry and public authorities. Special thanks go to the contributors of the presentations. The financial support provided by the German Research Association (DFG) is gratefully acknowledged as well. As a consequence of the success of the workshops, the workshop series will be continued. The next conference of the research programme will be held on December 10-11, 1998 and will focus on environmental related aspects of aluminium production. In addition, a conference on methods for an integrated evaluation of material flows is under consideration for 1999.

Further information about the research programme SFB 525, the sub-programmes, the involved institutes and the next conferences are available at http://sfb525.rwth-aachen.de/sfb525 and http://www.kfa-juelich.de/ste/welcome.html

It should also be mentioned that funds can be provided for a limited number of guest scientists in the context of the research programme.